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Severn Peanut Co. vs. Industrial Fumigant Co.

June 26, 2013

**EXHIBIT 1**

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I have been retained to conduct an investigation into the facts and circumstances surrounding the fire and conditions leading up to the fire at the Severn Peanut Co.'s (SPC) storage Dome (the Dome) in Severn, North Carolina. Industrial Fumigant Co. (IFC) had begun fumigation on August 4, 2009, on the SPC Dome. Smoke was detected on August 11, 2009. This report was prepared to provide a summary of information and provide my opinions and conclusions based on this information regarding the storage practices of SPC and the fumigation conducted by IFC. If necessary, additional reports may be submitted to reflect any changes to my conclusions arising from analysis of additional information.

## **Section 1. Background**

IFC certified fumigators Brian Lilley and Randy Taylor fumigated the SPC Dome in Severn, North Carolina, on August 4, 2009, with 49,000 tablets of Fumitoxin<sup>®</sup> upon request of RP Watson of SPC. On August 10, 2009, a burning odor in the area of SPC was detected and on August 11, 2009, a wisp of smoke was detected from the top of the SPC Dome. The Dome was built in 2005 and measured approximately 192 feet in diameter and 96 feet high at the apex. The Dome was constructed of concrete with walls as thick as 22 inches at the base. The exterior of the Dome was constructed of 2.5 to 3 inches of insulating foam and a rubberized membrane. The concrete floor of the Dome housed six channels for aeration ductwork. The aeration system was a downdraft or negative pressure system with fans located on the outside of the Dome. The Dome was also equipped with a temperature sensing system via 19 cables suspended from the roof into the product below. The temperature monitoring system was provided by Safe-Grain Co. The temperature cables could be monitored by a unit in a service room at the base of the Dome by plugging in a data collection unit to each cable. The data from the collection unit could be downloaded to a computer or printed. Temperatures were displayed on the panel of the collection unit. No automatic fan control system that would turn fans on and off without personnel attendance was purchased for the Dome. A headhouse was on top of the Dome covering the access opening where peanuts were dumped from the conveyor into the Dome from an opening in the headhouse floor. Adjacent to this access opening was location 15 x 41 inch hatch where IFC personnel inserted the tablets when fumigating the Dome when it was full. IFC had successfully fumigated the Dome using the same method in the past. When the Dome was not full and access to the Dome was available through the overhead door at ground level, IFC placed fumigant on sheets at ground level. On August 4, 2009, the access opening at the top had to be used for fumigant application because the Dome was too full to use the ground level door. The same crop of peanuts stored in the Dome was successfully fumigated in December, 2008, using the same methods used on August 4, 2009.

At the time of the fire, the SPC Dome housed farmer stock peanuts from the 2008 harvest. This commodity is regulated and defined under 7 CFR 1216.9. After grading and cleaning, the peanuts were placed in the Dome through the conveyor system at the top of the Dome. The aeration system was reported by RP Watson of SPC in his deposition to run occasionally during loading of the Dome to control dust, two hours per day during the cold months (December '08 to February '09) and for two hours on July 1, 2009, for Protect It distribution. The



Dome was sealed in February 2009, opened for Protect It application on July 1, 2009 for two hours and then sealed again until the IFC application on August 4, 2009.

## **Section 2. Best management practices for the storage of farmer stock peanuts**

Agricultural products must be managed using industry best practices that have been established to maintain as much of the product quality as possible during storage. “Best Management Practices” (BMP’s) are methods or techniques that consistently show results superior to those achieved with other means. They are used to maintain quality. The agricultural industry sometimes uses the term “good agricultural practices” (GAP) and the purpose is to create food for consumers or further processing that is safe and wholesome. The BMP’s (or GAP’s) for the storage of farmer stock peanuts are established and followed for the same reasons — to protect the quality of the peanuts during storage and to provide safe, wholesome peanut products/food for consumers.

Quality of agricultural products in storage never improves; at best the quality can remain the same as when it went into storage (Maier et al, 1987). The only other option is degradation in quality. The requirements for managing all agricultural products in storage are the management of temperature, moisture, air psychrometric conditions, insect activity and the development of mold. Farmer stock peanuts are no exception. Storage managers have several “tools” available to manage these conditions. Aeration systems, temperature monitoring systems, several methods for product sample gathering and testing, mold testing, relative humidity monitors, weather stations close to the storage location, and a wealth of information provided by the USDA-ARS and land grant universities are all resources readily available to managers to handle conditions to keep products in the best quality possible. Products go “out of condition” when excessive moisture provides an environment for molds to develop, biological activity from insects and mycotoxins to accelerate, and temperatures to increase, possibly to well over 200F. This biological “self heating” can cause spontaneous ignition and fire. (Mills, 1989)

Many agricultural products have organizations or councils that specify guidelines and provide information for their BMP’s. These practices are based on testing by scientists and producers and on the experience of people in the given industry. For farmer stock peanuts, the American Peanut Council and the American Peanut Shellers Association provide these guidelines to the peanut handling industry. The American Peanut Council sets forth the following guidelines for best management practices in the storage of farmer stock peanuts (APC):

- Due to the length of time peanuts are stored, it is critical to maintain adequate conditions to minimize losses in quality.
- Aeration fans should be actuated continually during filling (except when insecticides are in use). This will ensure continual air movement and heat exchange, thus keeping the temperatures of the over space air in equilibrium with ambient.



- A warehouse monitoring program should be "in place" to allow **weekly inspections** of all storage systems. A formal report indicating whether insects or damage are observed, whether condensation is occurring, as well as the general condition of the peanuts and storage structure should be filed and promptly acted upon as changing situations dictate. The report should also document corrective action recommended and corrective action taken.
- The goal of **the mold prevention system** is to ensure that conditions do not exist in the handling and storage of peanuts that would lead to the formation of molds (i.e., ensure that warm and humid conditions, which promote mold growth, do not exist).
- The following practices should be followed to minimize or eliminate the risks of microbial mold formation in peanuts:
  - Peanuts in storage should be **routinely checked** for evidence of mold. If mold is evident, the reason for mold formation should be immediately determined and corrected. Moldy peanuts must be removed from edible use.
  - Warehouseman should check **regularly** for leaks in roofs, walls and around doors and ventilators. Such an inspection should also be made while rain is falling on the building.
  - All down spouts into buildings should be periodically checked to see that their points of spout entry are securely closed and sealed to prevent entry of moisture during and following rain.
  - Special attention should be given to proper ventilation of tank type storage structures. **Regular checks for condensation are extremely important.**

The American Peanut Shellers Association publishes Handling and Storage of Farmers Stock Peanuts which states (APSA):

**For storage in monolithic Domes**, it is imperative that all peanuts be cleaned prior to loading because peanuts are usually loaded through a single opening at the center of the Dome. Foreign material and loose-shelled kernels will be concentrated directly underneath the opening and will severely restrict air movement.

From a practical standpoint, the ventilation fans should run continuously while peanuts are in the warehouse, except when fogging or fumigating with chemicals labeled for use in farmer stock warehouses. However, if proper temperature and humidity sensors are used to determine dew point conditions, they should take preference in controlling fan operation after excess heat and moisture have been removed.

Per this American Peanut Shellers Association's publication, the recommended aeration scenario for storing farmer stock peanuts in a Dome is a negative pressure system, pulling ambient air in through inlets located in the headspace and down through the peanuts. In this design, there is no headspace ventilation system and the aeration system **should be operated throughout the storage period using an aeration**



**controller responding to temperatures and humidity measured outside the warehouse and in the peanut mass.** The design airflow rate for this scenario is 10 cfm/ton.

The LSK and fine-textured foreign material will tend to concentrate along the centerline of the warehouse and fill in the air space between the peanuts causing increased pressure loss. Typically, the foreign material will double or triple the pressure drop through the peanuts.

#### Fan Operation:

The purpose of the farmer stock warehouse aeration system is to control the peanut temperature and remove excess moisture. Excessive fan operation can dry peanuts to below the desired minimum of 7% causing excessive shrink. Therefore, fan operation is critical especially after the initial cool down and equilibration period.

Once the ductwork is covered, then fan operation can begin.

To achieve equilibrium moisture content of 7%, peanuts must be stored at approximately 60% relative humidity. At 75% relative humidity, peanuts will equilibrate to about 9% moisture content. Therefore, to prevent over drying, fans should not be run when the relative humidity of the cooling air is below 60%. If drying still needs to occur for the majority of the peanuts in the warehouse, cooling air with slightly lower, e.g. 50%, relative humidity could be used for short periods of time. Running the fans when the relative humidity is greater than 75% increases the risk of wetting peanuts allowing for potential mold growth. Automated aeration control systems are available and highly recommended because they are more reliable than manual operation. Once the warehouse is loaded, then fan operation will continue until the peanut temperature has cooled sufficiently. This will usually occur within about 30 days. However, the cooler the peanuts the more stable the moisture and quality characteristics become. Once cooled, the peanut mass will maintain its temperature and will warm very slowly if the aeration system is not run. Again, temperature and humidity sensors in the warehouse will be very useful in managing the aeration systems.

Peanuts in storage should be **routinely checked** for evidence of mold. If mold is evident, the reason for mold formation should be immediately determined and corrected. Moldy peanuts should be removed from edible use.

Peanut peaks should be knocked down to allow heat and moisture to exit the pile.

Smith and Davidson (1982) found in their research that ideal conditions for normal storage periods of farmer stock peanuts are about 10 °C and 65 percent relative humidity. Safe storage at average kernel moisture content of 10 percent (wet basis) depends greatly on how much the moisture content of individual pods deviates from the average moisture content of 10 percent and on how quickly the peanuts can be cooled. Peanuts having kernel moisture contents above 8 percent (wet basis) will undoubtedly produce conditions very close to the

danger zone for mold growth. Peanuts have molded when stored for several months at average kernel moistures as low as 8 percent (wet basis). As microorganisms grow, additional heat and moisture are produced.

Mills (1989) published that advised maximum moisture content is 9% for unshelled peanuts...at temperatures up to 27°C. **Temperatures should be monitored at regular intervals.** Once heating has reached 176°F, the temperature will likely continue to increase until ignition occurs. Insects in dry bulks containing 15%MC or less can result in heating up to 108°F...permitting spoilage molds to grow and sometimes produce temperatures up to 142°F. Microbial activity can result in temperatures of 167°F. At this temperature, a purely chemical (aka oxidation) process may occur and raise the temperature of the material to ignition. When preceded by biological heating, chemical oxidation proceeds at a more rapid rate.

Several land grant university extension services and government agricultural research units publish fact sheets and research papers about best practice methods for storing agricultural products. Researchers from the USDA-ARS center at Dawson, Georgia, Oklahoma State University, University of Illinois, and Iowa State University concur on the following prescription for storing farmer stock peanuts:

- **Run the aeration system continuously** as soon as the aeration ducts are covered and until the temperature reaches the ideal storage temperature of 40 F and RH between 55 and 70%. Using automatic controllers, aeration should be used throughout the storage period, turning on fans when the temperature and RH outside are at optimum levels (air temperature cooler than product temperature and RH at a level to control rewetting or drying of the product)
- Inshell peanuts should be **monitored once per week** for insect activity, mold, water leaks, and condensation under the roof and down the walls. If an automatic controller isn't used for temperature monitoring and fan operation, temperatures should be monitored in the headspace and throughout the peanut bulk. These readings should be stored and compared to detect increases. When increases occur beyond average daily ambient temperatures or the temperature changes are in excess of the aeration vendor's recommendations for temperature increase warnings, investigation must commence immediately to understand why the temperature is changing. Research shows that temperatures increase due to insect activity or high moisture levels. Certain insects are attracted by high moisture areas in the storage bulk, thus compounding the heating issue in that area. This situation develops a "hot spot" that must be disrupted and the insect activity must be eradicated.

Aeration cannot do its job of cooling and drying if areas of the peanut storage are packed or the void space between the individual peanuts is filled with trash, fine material or broken product. Air always takes the path of least resistance and will travel through the areas around the packed material. In essence, the packed material never reaps the benefits of aeration since the air does not travel through that part of the storage bulk. Many times this fine material or packed material occurs in the center of the storage facility, particularly in the case of

Domes and bins that are loaded from a central point at the top of the roof. This causes a very high-risk area for insect activity and for mold and microbial growth. Careful attention must be paid to this area and remedial action must be taken.

It is paramount that managers of aeration systems in any agricultural product understand the concept of equilibrium moisture content (EMC) and equilibrium relative humidity (ERH) for their stored product. When the relative humidity (RH) of ambient air is greater than the ERH at a given temperature for the peanuts, rewetting of the peanuts can occur. For relative humidity lower than the ERH for a given temperature, drying of the peanuts can occur. One can see how important this knowledge and proper use of the data provided for the product in storage can be when making decisions to run the aeration system. Drying may not always happen just because the ambient air is cold and rewetting may not always happen when air is warm. The RH plays a major role. All products have their own EMC/ERH “rules” that must be followed to maintain the product at desired storage conditions. Peanuts are no exception. This information is readily available from any land grant university extension service, commodity groups and from the USDA-ARS service. In fact, automatic aeration controllers operate based on the “rules” of EMC/ERH for a particular product. That is one of the advantages of automatic controllers. But in the absence of this kind of technology, aeration system managers must be aware and make use of this information in order to make aeration operation decisions that maintain their stored product at the desired moisture content and temperature identified by research and published best management practices for the industry. Knowledge of the temperature of the product, moisture content of the product, RH within the storage unit, ambient temperature and ambient relative humidity is necessary to keep conditions in balance for safe storage and the best possible product condition.

Insect monitoring is very important in the storage of farmer stock peanuts, as well as any agricultural product. Indian meal moths and red flour beetles are reported to be the most prevalent in peanut storage facilities. Indian meal moth larvae spin a thread as they feed forming a web over the top surface of the product. This web causes drastic reduction in the effectiveness of fumigants and of aeration systems by increasing static pressure. Moisture can develop under the areas of the webbing and aeration is limited in controlling this moisture due to the lack of the aeration system’s ability to move air through the webbing. Red flour beetles are common in peanut storage and produce quinones that give the product an off-odor and off-flavor. Both insects are difficult to manage and show some amount of resistance to fumigation. Diligent monitoring of these insects will go a long ways in managing their populations. During warmer seasons, weekly monitoring is important to detect population dynamics. Life cycles of these insects can be as short as one month. Populations can obviously increase quickly if not monitored and treated.

Grading by the USDA provides guidelines for the industry that insure that the products covered under government loans are stored properly and held at the very best quality possible through the storage period. Much research has been conducted through the years by university and USDA researchers to determine these optimum and safe levels for storage. Committees and review boards have agreed on these standards for the

grading levels of peanuts and these standards are used by the USDA graders upon delivery of the peanuts to the buying and storage facility. For the human consumption grade for peanuts (Seg I), farmer stock peanuts must meet certain standards before they can be placed in storage and covered under the government loan program. 7 CFR 996.30(b) states:

Moisture: “Domestic and imported peanuts shall be dried to 18 percent or less prior to inspection and to 10.49 percent or less prior to storing or milling: *Provided*, That Virginia-type peanuts used for seed shall be dried to 18 percent or less prior to inspection and to 11.49 percent or less prior to storing or milling.”

Dr. Chris Butts, peanut storage expert and researcher with the USDA-ARS reports that:

“Under the current regulations, the official thresholds for moisture, foreign material, excess splits, and damaged kernels are for each load. Under the current regulations, for marketing purposes (placing the peanuts in the marketing loan program) the grade sample from **each load must have a kernel moisture content less than or equal to 10.49%** (less than 10.5%).”

The buyer and seller can agree that a sample can be graded and marketed at kernel moisture content up to 18% (wet basis) using grade conversion charts based on research that Dr. Butts and his researchers conducted. It is then the responsibility of the buyer to dry the peanuts to 10.49% moisture content for safe storage prior to putting the peanuts in storage. Peanuts sold as “seed peanuts” can have a moisture content up to but not including 11.5%. If they are not used for seed, they may be stored with Seg I peanuts if they meet the standards for the Seg I grade. (Butts, 2013).

### Section 3. Severn Peanut Dome and August 4, 2009 IFC Fumigation

The Severn Peanut Dome is a 192 ft diameter x 96 ft tall Dome with an interior volume of 1,976,503 ft<sup>3</sup> as reported by SPC to IFC, equipped with temperature cables and aeration and built in 2005. A head house was located at the top of the Dome where peanuts would dump from the conveyor into an opening in the apex of the Dome. The Dome has had three crops of farmer stock peanuts stored in it. The first crop was placed in storage in 2005 and removed in 2007. The second crop was placed in storage in 2007 and removed in 2008. The third crop was placed in storage in 2008 and removed after the fire in the Dome in 2009.

IFC was contracted by SPC to provide fumigation services and they provided that service when SPC personnel (RP Watson) contacted them to request the service. Testimony by SPC personnel indicated that SPC had a great deal of trust in IFC and their fumigators and continued to use their services even after the Dome fire.

In the fall of 2008, the Dome was loaded to near the top of the Dome. SPC testimony states that the peanuts settled to a level of about 25 ft below the apex of the Dome. The 2008 crop stored in the Dome was fumigated by IFC with Fumitoxin tablets on 12/18/08 and 08/04/09. IFC had successfully fumigated the Dome prior to the

third crop and successfully fumigated other warehouses and bins owned by Severn Peanut Company. On 08/04/09, IFC used 49,000 tablets of Fumitoxin at an application rate of 24.8g/1000 ft<sup>3</sup>, well within the label dosage limits, to fumigate the Dome. SPC personnel had applied Protect It, a diatomaceous earth protectant product, to the top surface of the peanuts prior to the December 2008 fumigation and again in July of 2009. SPC personnel report that both the DE application and the fumigation were standard procedure for their company before peanuts were to be removed from storage, not in response to a population increase of insects. IFC fumigators report that Indian Meal Moths flew out of the Dome when they opened the access hatch to apply the fumigant tablets. The tablets were distributed to the peanuts below through the hatch at the top of the Dome. IFC fumigators, Brian Lilley and Randy Turner, reported seeing the peak of the peanuts about 20 ft below and heard the tablets as they went down the slopes of the peanuts. They report that they slung the tablets from the flasks by rotating their wrists as they emptied the tablets into the Dome. They took a flashlight and inspected the peanuts to make sure no stacking or piling of tablets had occurred. This was the same method that had been used when IFC treated the Dome in prior successful fumigations. The application rate was the same as was used in the December '08 treatment but less than in prior years' treatments.

### **Section 3.1. SPC's failure to follow best storage practices**

Review of the depositions provided by personnel from SPC, IFC, Safe-Grain, and Degesch provided the following information about SPC's management practices regarding the Dome and its contents and how those management practices deviated from the BMP's discussed earlier in this report and adopted by the peanut industry.

- 3.1.a. SPC stored in the Dome farmer stock peanuts that exceeded the moisture content permitted by 7 CFR 996.30(b), a standard established to ensure that stored peanuts do not develop mold growth and do not self-heat.
  - RP Watson testified that SPC does not take peanuts with moisture content higher than 10.49% because "that's a standard in the industry and I think there's a lot of years of research backing up that—that number so that —they know that peanuts, if you put them in warehouses at moistures higher than that, they can have—you can have problems with them. Aflatoxin, mold."
  - However, in Lee Wade's testimony and in Exhibit 60, several loads of peanuts were placed in the SPC Dome with moisture content of 11-12%.

**Consequences** of these loads of peanuts going into the Dome are layers or pockets of high moisture peanuts within the storage bulk. While the average moisture content of the entire Dome storage may have been below 10.5%, high moisture peanuts were placed into the Dome causing layers or pockets of higher moisture product. Mr. Wade's testimony indicated that peanuts accepted for seed at 11.49%



moisture content were also placed in the Dome. The aeration system was not run continuously while the Dome was being loaded according to BMP from the peanut associations. The wet peanuts had little chance to dry before more peanuts were loaded on top of these wet layers. This established optimal conditions for mold to develop within the peanut storage bulk and temperatures to increase due to biological heating.

3.1.b. SPC failed to monitor the peanuts stored in the Dome to determine whether their moisture content was increasing or whether the relative humidity inside the Dome was increasing

- SPC personnel (RP Watson) testified that the moisture content of the peanuts within the Dome was never checked or monitored once the peanuts were placed in the Dome. The relative humidity was not monitored either.

**Consequences** of not monitoring moisture content of the peanuts in storage and the relative humidity of the air within the Dome are heating problems within the Dome and high humidity conditions developing within the Dome due to condensation or temperature rise going undetected. Without knowledge of the moisture content of the peanuts and the RH both inside the Dome and of the ambient air used to aerate the Dome, the manager could not be sure of whether the moisture content is being increased by aeration or the peanuts are being dried below the desired level for shelling. High moisture content and high relative humidity are both conducive to mold formation within the peanuts.

3.1.c. SPC failed to monitor the peanuts stored in the Dome for the development and growth of mold even though industry guidelines require peanut processors to “routinely” check stored farmer’s stock peanuts for evidence of mold.

- RP Watson stated in his deposition that he had seen and was aware of the American Peanut Shellers Association document called “Handling and Storage of Farmer Stock Peanuts” but the last time he had looked at might have been as long as ten years ago.
- RP Watson stated in his deposition that SPC does not routinely check peanuts for mold. He stated that employees were in and out of the Dome from time to time and if someone noticed any mold, they would have reported it.
- SPC had no routine process through which they checked for mold of peanuts in the Dome storage.

**Consequences** of not having a routine schedule and method for checking for mold in the Dome peanut storage are failure to identify an area within the Dome storage that could turn into a self-heating problem



within the bulk of peanuts and failure to remediate the problem causing the mold. Even though RP Watson and some of his employees were aware of the industry BMP's through the American Peanut Shellers Association document as stated in his deposition, no method or schedule to inspect for mold was in place. The observation of mold was left to chance while employees were doing other jobs within the Dome. There was no indication that the employees had been trained as to what to look for when looking for mold.

The Dome was sealed in February and not opened again until the Protect It was distributed through the top hatch. No samples were drawn from unloading chutes, no samples were pulled from any of the openings in the Dome, and no opportunity for employees to inspect the peanuts for deterioration or mold occurred. Therefore, any mold developing in the Dome went unremediated, the causes went unremediated, and, with no change in the Dome environment, any mold was left to propagate to the point of self-heating and combustion.

3.1.d. SPC failed to determine if pest problems within the Dome were getting worse.

- Testimony by SPC personnel (RP Watson) stated that the only detection of insects used by SPC was pheromone traps and he was not sure they were used in the Dome.
- After fumigation, SPC personnel never inspected to see if the fumigation was effective, if the insects were still active or that the population dynamics of the insects was getting worse or improving.
- SPC had no routine process through which they would determine the pest population in the Dome.

**Consequences** of not monitoring insect population dynamics are damage to the peanut and kernel making the product unmarketable, biological activity leading to mold from the high moisture pockets caused by the insect body functions and respiration, and, in the case of Indian Meal Moth, aeration system air distribution difficulties due to webs formed on the top of the product surface. Several kinds of traps are available on the market. These range from electronic insect counter traps to pheromone sticky traps. Visual inspection with a flashlight through the top opening of the Dome would have helped to identify Indian Meal Moth populations.

3.1.e. Though it had the ability to monitor the temperature of the peanuts in the Dome any time it wanted to, SPC did so only six times between September 2008 and the time of the fire.



- Safe-Grain recommended a routine monitoring schedule to ensure that problems were not developing.
- Safe-Grain, the provider of the temperature monitoring system, prescribes routinely monitoring the temperature cables at least three times each week and daily if the product being stored is an expensive product with a high financial risk.
- SPC monitored the product six times compared to the manufacturer's recommendation of at least 84 times between September 2008 and August 11, 2009.

**Consequences** of not monitoring temperatures of the Dome and the peanuts stored in the Dome are that no opportunity existed for SPC to detect a mold or moisture problem in the Dome since it did not visually inspect or use any other method of inspecting the stored peanuts or the environment within the Dome. With no current information about the temperature of the peanuts, moisture content of the peanuts, and the RH within the Dome, prudent aeration decisions could not have been made. This information is critical in the decisions based on EMC and ERH whether to run aeration fans at a time when the product would be cooled and not either rewetted or excessively dried. While SPC had a temperature monitoring system capable of giving the appropriate information when used properly, SPC failed to follow both industry BMP's and the manufacturer's instruction which may have resulted in non-detection of inappropriate aeration control and the inability to catch troubling hotspots within the peanuts in time to stop mold formation and biological heating within the peanuts.

3.1.f. SPC failed to appreciate that temperature increases within the peanuts between March 2009 and July 2009 suggested a significant problem requiring action.

- SPC personnel (Lee Wade) testified that nothing in the temperature readings led him to believe that there was a problem within the Dome.
- Safe-Grain president, Scott Chant, testified that the temperature readings between March 2009 and July 2009 indicated that the peanuts were self-heating.
- Safe-Grain instructions (exhibit 103) gave SPC specific temperature increase ranges at specific temperatures when SPC should take action to resolve.
- SPC failed to respond to temperatures that increased beyond the guidelines established by Safe-Grain.

**Consequences** of SPC's failure to appreciate and react to the temperature increases within the peanuts caused formation of hot spots or areas within the peanut bulk storage. As mentioned earlier, these hot spots, which are some kind of biological activity like mold forming, peanuts deteriorating or insect



populations increasing, will continue to grow and encompass more peanuts. The progression can advance exponentially when left undisturbed and untreated. Ultimately, self-heating of the product can lead to ignition and combustion of the peanuts. SPC's RP Watson stated that he believed that the peanuts were different than grain and that Safe-Grain's instructions (ex 103) did not apply to the storage of peanuts. He goes on to say that the kernels have a type of safety protection in the form of the hull and storage was not like storing shelled peanuts. However, Mr. Watson failed to consider that the hull itself is a bioproduct and is susceptible to deterioration, high moisture content, insect invasion, and self-heating. Research by Fasina (2006) shows that peanut hulls have a higher heating value than switchgrass, a biofeedstock now being used for biofuel and direct fire alternate heating (19.92 MJ/kg vs 19.2 MJ/kg). Compared to corn kernels (18.14 MJ/kg heating value) that have been known to self-heat and combust under high moisture conditions, peanut hulls have at least as much potential as corn kernels for rapidly increasing temperatures during deterioration. SPC did not react to the increase in temperatures indicated by the Safe-Grain monitoring system, therefore allowing the bulk to continue to heat without any additional monitoring or remediation.

3.1.g. SPC failed to follow Safe-Grain's written instructions and industry guidelines in the manner in which it stored peanuts in the Dome and to take sufficient action to address the self-heating of the peanuts within the Dome.

- Scott Chant of Safe-Grain stated in his testimony that SPC did not take action based on the manufacturer's instructions or the industry BMP's when the temperatures within the Dome increased due to biological activity.
- Mr. Chant also stated in his deposition that SPC did not follow industry BMP's in their storage of the peanuts.

**Consequences** of not storing peanuts according to BMP's and not reacting to the increase in temperature due to biological heating led the peanuts inside the SPC Dome to continue to heat to a point of ignition. High moisture content layers of peanuts were placed into storage causing pockets or layers of moisture. Monitoring of the temperature within the Dome was sporadic and was not used to detect problems within the Dome (per SPC testimony) and no action was taken to remediate the increasing temperatures. SPC did not inspect or test the peanuts or the Dome to determine the cause of the temperature increase. SPC failed to appropriately react to the increasing temperatures according to published industry guidelines from at least two national peanut organizations.

3.1.h. SPC failed to employ Safe-Grain's aeration fans as suggested by Safe-Grain's guidelines and recommendations, which directly resulted in the formation of vertical columns of peanuts conducive to the development and growth of mold.



- Safe-Grain's instruction for the use of the aeration system installed in the Dome was to run the fans continuously until the entire product bulk was at the desired temperature and then to turn them off. They should remain off until a temperature rise occurs beyond those allowable in Safe-Grain's warning chart. Then the fans should be turned back on to remedy the temperature rise and return the bulk to the desired temperature again. SPC did not follow these instructions. According to SPC testimony, the fans were run for two hours every day between December and February regardless of what the temperature monitoring system indicated. The fans were then sealed and not used again until the Protect It was applied, run for two hours, then sealed again until the August 4<sup>th</sup> fumigation.
- RP Watson and other SPC personnel testified that every season of peanut storage in the Dome had resulted in a "soldier" or a column of peanuts in the center of the Dome. The largest was in the crop that was stored for two years. Mr. Chant attributes this column of peanuts to the misuse of the aeration system.

**Consequences** of not using the aeration system according to manufacturer's instructions and in aerating according to the procedures reported by SPC personnel would be the formation of soldiers or solid columns of peanuts within the Dome. RP Watson stated that these soldiers were from the packing of the peanuts during loading of the Dome and that the individual peanuts were easily broke free and were viable peanuts. However, he also stated that heavy equipment had to be brought in to knock down the soldier before it fell on someone and caused injury in a previous year's storage. Dr. Butts and other industry representatives define a "soldier" as peanuts stuck together due to high moisture content and mold formation. The fine material in the center of the Dome where the peanuts were loaded prevented the aeration system from blowing air through this core of fines. The temperature and the lack of aeration in this area provided a haven for mold formation (Chant's deposition). This phenomenon is known to happen in all agricultural product storage including unshelled peanuts. Pictures taken of a previous year's storage in the Dome show a large soldier where individual peanuts could not be observed, only the solid column of peanut bulk.

Running the aeration during loading of the Dome is intended to equilibrate the temperature and moisture of the material going in to the Dome and to distribute fine material more evenly in the Dome. According to SPC testimony, the fans were run occasionally to handle dust during loading and for two hours every day between December and February regardless of what the temperature monitoring system indicated. The fans were then sealed and not used again until the Protect It was applied, run for two hours, then sealed again until the August 4<sup>th</sup> fumigation. The material in the column of peanuts had opportunity to establish without disturbance from aeration or from mechanical handling such as a spreader or heavy

equipment during loading. The correct conditions for mold in the center of the Dome allowed mold to form in the soldier undisturbed.

Sensing the temperature would have detected the rising temperature in the soldier as mold formed in the soldier. Responding to the temperature rise would keep the temperatures in check, preventing further damage to the product and further deterioration to the point of combustion.

### **Section 3.2. Fumigation Conducted by IFC**

Section 3.2.a. Review of the Degesch product label and the testimonies and reports from IFC indicate that IFC fumigators were within the law in their methods and followed industry practices. Some of the pertinent points are listed below:

- This product is labeled for peanuts as well as many other agricultural products in storage.
- Minimum exposure for tablets at the temperature on August 4, 2009, was three days.

Note: Tablets were chosen for this fumigation and they react more slowly than pellets because of the smaller surface area of the tablets compared to pellets.

- Exposure time must be lengthened to allow for penetration if the fumigant is not uniformly added to the commodity mass as in surface application or shallow probing. This is particularly important for large storage.

Note: IFC allowed extra time for this penetration. The Dome was still under fumigation when smoke was detected on August 11. IFC was following the label information for the length of the fumigation.

- Maximum dosage for tablets is 145/1000 cu ft.

Note: IFC was well within the dosage limits.

- A certified applicator must be physically present, responsible for and maintain visual and/or voice contact with all fumigation workers during application and during openings of containers. Once the application is complete and the structure is secure, the certified applicator does not need to be physically present.

Note: IFC followed this requirement per its fumigation report.

- A certified fumigator must be present and responsible for and maintain visual and/or voice contact during initial opening of the structure for aeration at the end of the fumigation. Once secured, trained personnel can complete the process and remove the placards.



Note: The Dome was still under fumigation on August 11. IFC followed all requirements in taking the Dome out of fumigation upon notification of the fire.

- Gas detection equipment can be glass tubes with a hand pump to draw air samples or it can be electronic sampling devices. These devices must be in compliance with the manufacturer's recommendations.

Note: IFC followed this requirement by using both Draeger tubes and an electronic monitor.

- Local officials must be notified of the impending fumigation and given MSDS and label information.

Note: no time period is designated for when this notification must be given. IFC notified all local officials prior to the fumigation.

- Two people (certified applicator and a trained person) or two trained persons under the certified applicator's supervision must be present when entry into a structure for application is required.

Note: No entry was made into the Dome for application. The hatch was opened and tablets were inserted.

- Placarding: IFC diligently followed all placarding requirements
- Inspect structure to see if it can be sealed adequately

Note: IFC inspected the structure and sealed the Dome adequately as it had done in previous successful fumigations of the same structure. SPC reported no changes in the structure.

- Written fumigation management plan must be written prior to treatment

Note: No time is specified as to how long prior to the treatment the plan must be written. IFC had a FMP in place prior to the treatment on August 4, 2009.

- Prior to each fumigation, review any existing FMP, MSDS, product labeling, and relevant safety procedures with company officials and employees.

Note: No time is specified as to how long prior to each fumigation the review must take place. Also, reference is given to "any existing FMP", indicating that existing FMP's can be used as long as they are updated if any changes occur in the structure. SPC reported that no changes had occurred in the structure so there was no reason to write a new FMP for this fumigation.



- Apply fumigant from the outside where appropriate

Note: IFC applicators determined that it was appropriate to apply the fumigant from outside of the Dome. Their method of application is accepted in the agricultural industry and quite commonly used in structures where access at the top of a previously loaded and already full storage unit is available. In SPC's expert reports, mention was made that the IFC fumigators should have entered the dome during the fumigation. This is not only not practical given the geometry of the Dome, because the only way to enter the Dome would have been through the top hatch with nothing to secure to or stand upon, doing so would have posed an unnecessary safety issue for the fumigation team. OSHA is in conversations at present with several states that would keep workers from entering grain storage units for any reason when the crop is being stored. Entering a gaseous atmosphere even with the appropriate personal protective equipment is considered unnecessarily hazardous if any other method of application is available. The method of application used by IFC is approved in the label and is widely used throughout the agricultural industry for bulk commodities already placed into storage. There was no reason for IFC fumigators to enter the Dome during this fumigation and add risk for the fumigation team.

- Inform business/client that employees/other persons may return to work or otherwise be allowed to re-enter the aerated structure.

Note: The Dome was still under fumigation when smoke was detected on August 11. IFC monitored and made sure the area was safe before allowing entry to the Dome.

- Fumitoxin tablets or pellets ...may be scattered over the surface OR probed into the grain....

Note: The application of tablets by scattering over the surface of the commodity is a common practice in the environment IFC encountered with the Dome on August 4, 2009.

#### Section 3.2.b. Piling or stacking of tablets:

In my work as a stored product engineer engaged in research and extension work, I have demonstrated for fumigation certification classes many times the handling of Fumitoxin tablets using "demonstration tablets" that have many of the same physical properties as Fumitoxin but without the fumigant included. My experience has been that the tablets are hard to stack by hand... much less pile the tablets by dropping them from 25 feet above. These tablets have a slick outer surface and they tend to bounce when they hit each other, thus adding to scattering of the tablets below. The angle of repose has never been established for Fumitoxin tablets but when I tried to stack these demonstrator tablets by hand, the angle of repose was very low. They simply slide off of each other and off the pile. In summary, it is very difficult to accidentally pile these tablets due to their slick surface and their geometry – it is even difficult to intentionally do so.



Each of SPC's experts has opined that Turner and Lilley applied the tablets in a manner that left piles or stacks on the surface of the peanuts. Yet there is no evidence of such piling or stacking in any of the material I have reviewed – not a single witness observed such piling or stacking of tablets immediately following the application or at any time during the fire investigation which transpired from August 11, 2009 until September 2009. Thus, SPC's experts must be making an assumption that piling or stacking could not have been avoided from the method IFC's applicators utilized to apply the fumigant. Simple math, however, establishes the fundamental flaw in their assumption. Even assuming that the surface area of the peanut pile was smooth, its surface area was at least 66,000 square feet. Yet the total exposed surface area of the applied tablets, had all tablets been placed where they touched each other, would only have been 108 square feet, thereby constituting less than 0.16% of the peanut pile surface. As a purely mathematical proposition, therefore, piling or stacking of tablets was not an inevitable – and not a likely – consequence of the application performed by Turner and Lilley. Furthermore, they testified that following the application they looked at the surface of the peanut pile beneath the hatch with a flashlight – supposedly where the “flat spot” was located – and did not observe any piles or stacks of tablets. Finally, due to the 20-25 feet between the hatch and the top of the pile, the slick surface of the tablets, and the sloping sides of the pile created by the angle of repose, gravity would have greatly assisted the scattering and distribution of the 49,000 tablets they applied. Consequently, there is no evidence of any kind that supports the conclusion that Turner and Lilley violated the manufacturer label by applying the tablets in a manner that resulted in piles or stacks. Furthermore, Turner and Lilley made a reasonable decision to apply the Fumitoxin tablets in the manner they did even though the label warned against piling or stacking of tablets – there was no reason why they should have concluded, prior to the application, that their chosen method of application would likely result in piles or stacks of tablets on the surface of the peanuts.



#### Section 4. References

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<http://www.peanut-shellers.org/pdf/HandlingStorageManual.pdf>

American Peanut Council. Best management practices for the storage of farmer stock peanuts available at:  
<http://scientificteaching.wisc.edu/old%20website/products/PeanutFiles/library/places/USpeanutstorage.html>.

American Peanut Council. Good agricultural practices for farmer stock storage and handling. The Peanut Files available at:  
<http://scientificteaching.wisc.edu/old%20website/products/PeanutFiles/library/places/USpeanutstorage.htm>

[Butts, C., USDA-ARS Georgia Peanut Research. Personal communications.](#)

Butts, C., J. Chastain, J. Dorner, T. Sanders, M. Lamb, and D. Rowland. 2005. Storing farmers stock peanuts in monolithic Domes. ASABE Annual International Meeting, Paper no. 056182. Tampa, FL.

Davidson, J.I., T.B. Whitaker and J.W. Dickens. 1982. Grading, cleaning, storage, shelling and marketing of peanuts in the United States. In: H.E. Pattee and C.T. Young (eds) *Peanut Sci. Technol.*, Amer. Peanut Res. Ed. Soc., Yoakum TX, pp. 571-623.

Diener, U.L. and N.D. Davis. 1977. Aflatoxin formation in peanuts by *Aspergillus flavus*. Auburn Univ. Agric. Exp. Stn. Bull. 493.

Fasina, O. 2006. Fow and physical properties of switchgrass, peanut hull, and poultry litter. *Transactions of the ASABE* 49(3): 721-729.

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Maier, D., L. Mason, and C. Woloshuk. 1997. Maximize grain quality & profits using S.L.A.M.: the post-harvest IPM strategy. Purdue University fact sheet ID-207.

McIntosh, F.P. and J.I. Davidson. 1971. Effect of temperature on shelling runner- and spanish-type peanuts. USDA, ARS 52-65, U.S. Govt. Print. Office, Washington DC

Mills, J.T. 1989. Spoilage and heating of stored agricultural products. Research Branch, Agriculture and AgriFood Canada.

Oklahoma State University, Oklahoma Cooperating Extension Service. 1995. Fumigation, Category 7C. Stillwater, Oklahoma.



Smith, J.S. and J.I. Davidson. 1982. Psychometrics and kernel moisture content as related to peanut storage. *Trans. Amer. Soc. Agric. Eng.* 25:231-236.

Sundaram, J., C. Kandala, and C. Butts. Research Project: Systems to assess, monitor, and preserve peanut quality and safety. Dawson, Georgia Peanut Research.

Steele, J. 1974. Resistance of peanuts to airflow. *Transactions of ASAE* 73: 573-577.

Suter, D., K. Agrawal, and B. Clary. 1975. Thermal properties of peanut pods, hull and kernels. 1975. *Transactions of the ASABE* 72: 370-375.

Sutton, J. and S. Fletcher. 2011. An economic analysis of alternative peanut grading systems and the potential impact on the U.S. peanut industry. Final Report. USDA-Federal State Marketing Improvement Program.

University of Illinois Extension Service. 1997. Illinois Pesticide Applicator. Urbana, Illinois.

Young, J., and T. Whitaker. 1973. Specific heat of peanuts by differential scanning calorimetry. *Transactions of the ASAE*. 16(3): 522-524.

Severn Peanut Co. vs. Industrial Fumigant Co.

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Respectfully submitted by Carol L. Jones, PhD, PE

*Carol L. Jones, PhD, PE*

6/26/2013

Carol L. Jones, PhD, PE

Date :

Severn Peanut Co. vs. Industrial Fumigant Co.

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Respectfully submitted by Carol L. Jones, PhD, PE

*Carol L. Jones, PhD, PE*

*6/26/2013*

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Carol L. Jones, PhD, PE

Date :



## **Curriculum Vitae**

### **CAROL L. JONES, Ph.D., P.E.**

Associate Professor for Stored Product Engineering

Biosystems and Agricultural Engineering Department

Oklahoma State University

### **ACADEMIC BACKGROUND**

Ph.D, Biosystems Engineering, Oklahoma State University, 2006

B.S., Agricultural Engineering, Oklahoma State University, 1977

### **MAJOR AREAS OF INTEREST**

#### **Research**

Grain quality management; Grain bin design and safety standards; Dielectric studies on plants and grain; Canola storage; Closed Loop Fumigation; Bin Heating for insect control; Dielectric identification of insects; Dielectric studies of herbs, oilseeds, and nuts; Ozonation of stored products; Harvest, storage and transportation of lignocellulosic biofeedstock; Grain storage conditions predictive modeling; Precision storage techniques; biosecurity, traceability, and food safety



### **Extension**

Grain bin safety standards; Grain and oilseed storage; Canola storage; Closed Loop Fumigation; Aeration; Harvest, storage and transportation of lignocellulosic biofeedstock; Precision storage techniques, on-farm grain storage, grain storage safety training; traceability and food safety

### **Teaching**

Physical Properties of Biological Materials

Processing Methods

Study Abroad: Technology of Northern Italy and Technology of Brazil

### **PROFESSIONAL EXPERIENCE**

Associate Professor, Biosystems & Agricultural Engineering Department, Oklahoma State University, 2011-Present.

Assistant Professor, Biosystems & Agricultural Engineering Department, Oklahoma State University, 2006-2011.

Manager, Boeckman Farms, Omega, Oklahoma, 1984-2013.

Research Engineer, Biosystems & Agricultural Engineering Department, Oklahoma State University, 2002-2006

Technology Coordinator, Network Administrator and Secondary Math Instructor, Dover Public Schools, 1994-1999, 2001-2002.

Network Manager, Oklahoma Department of Career and Technology Education, 1999-2001

Facility Manager, Design Engineer, W. L. Somner Co., 1982-1984



Design Engineer, Manager of Marketing Applications Engineering, Worthington Pump Co., 1978-1982

Student Lab Assistant, Oklahoma State University, 1974 – 1978 (peanut research with Dr. G. Brusewitz)

## **TEACHING EXPERIENCE**

BAE 2022/3: Physical Properties of Biological Materials, Sp 2007 – present

BAE 4400: Topics in Processing, F 2006, Sp 2007

ENGR 4060: Technology of Northern Italy (Study Abroad Class) Su 2007, Su 2008

ENGR 4060: Technology of Brazil (Study Abroad Class) Su 2009 - present

Lectures for BAE 1012 and BAE 4012 on Web Site Development 2004 - present

## **PROFESSIONAL AFFILIATIONS**

American Society of Agricultural Engineers, member 8 years

FPE-702 Crop & Feed Processing & Storage, 2007 – 2015, Chairperson 2013-2014, Vice Chair 2010-2012, secretary 2007 – 2009, session moderator 2009-2013.

IET Division Associate Editor – Electromagnetics and Spectroscopy – *ASABE Transactions*

D309.2 (FPE702) Standards Revision Committee, 2007 Chairperson

FPE703 Food Processing, session moderator 2008

FPE712 Fruit and Vegetable Post Harvest Committee, 2006 – 2010

FPE03 Standards Committee representing IET, 2006-2008



IET-348 Electromagnetics and Spectroscopy Committee, 2006-2010, Vice-Chairperson, Session moderator

IET Division Invited Select Paper Competition Committee 2007, 2008

Advisory board, Grain Entrapment Prevention Council, 2009 – 2013.

Grain Elevator and Processing Society (GEAPS) 2006-2008

Cherokee Strip GEAPS Chapter

OSU's representative to NC-213, a multi-state research committee for U. S. Quality Grains Research, Secretary 2010, Chairperson 2012-2013

Professional Engineer, Oklahoma Registration

InfraGard Board of Directors Member

Oklahoma AgroTerrorism Task Force

eXtension Farm Safety section advisory and review committee member

Board member of Emergency Services Training Centre

Contributing Author for *Grain Journal*, 2013 - 2014

## **AWARDS AND HONORS**

Editorial Board Member for the Journal of Stored Products Research

Gamma Sigma Delta – Agriculture Honorary Society



SBIR Review Committee Invited Reviewer 2008

Southern Region S.A.R.E. R&E Review Committee Invited Reviewer 2009

Sun Grant Biomass Feedstock Logistics Competitive Grant Invited Reviewer 2008

U.S. Department of State Science Center, Los Alamos, Sandia, Lawrence Livermore, Brookhaven, and Pacific NW National Laboratories Grant Invited Reviewer 2010

Invited committee member to represent the Central US for the International Center for Global Grain Industry

USDA Partnership Award – Biofuel Products and Energy Group 2011

Alpha Epsilon Distinguished Service Faculty Award, 2011

Advisor for CASNR Outstanding Student Association 2010-11

Board of Directors for InfraGard (Oklahoma Chapter) 2011-13

Selected Reviewer for USDA NIFA Engineering Products and Processes Panel 2011 and 2013

Elected Representative to Faculty Council from Department of Ag Sciences and Natural Resources 2012 – 2014, committees: Academic Standards and Policies; Campus Facilities, Safety and Security

Section Head for international conference for the 11<sup>th</sup> International Working conference on Stored Product Protection, Chiang Mai, Thailand. 2013.

Outstanding Study Abroad Faculty Member, Oklahoma State University President's Awards, 2013.



## **MENTORED STUDENT SUCCESSES**

Flint Holbrook:

I mentored Flint as his academic advisor, writing letters of recommendation and targeting award opportunities. He received the Udall Scholarship, Top Ten Senior Men and is the current SGA President for OSU.

Jessica Lay:

I mentored Jesi for three years. Highlights of her accomplishments include receiving the Udall Scholarship, OSU Hall of Fame, Senior of Significance, NSF graduate assistantship, Cambridge Study Abroad opportunity.

Jacob Biros:

I mentored Jake through his international study efforts. He received scholarships to continue his engineering studies in Japan for a semester and one summer in Argentina.

Laura Merriman:

I mentored Laura from her freshman year through her current year as senior in Biosystems Engineering. She is a Senior of Significance and the leader for the WEATIES women in engineering group.

Stephen Eller:

I mentored Stephen from his freshman year through his acceptance to his graduate program. Stephen was president of the College of Agricultural Science and Natural Resources Student Council, a Senior of Significance, a Top Ten Freshman and a Top Ten Senior Man.



Currently I advise 40+ undergraduate students through their Biosystems Engineering Biomechanical Option programs of study.

## **COMMITTEE SERVICE – 2006 - PRESENT**

### **Department**

Department Undergraduate Curriculum and ABET Committee, 2007-present

FFA Career Development Events Committee, 2006 - present

Reappointment, Promotion, and Tenure Committee, 2007-2008

Department Awards Committee Co-Chair, 2007-present

BAE Department Webmaster, 2006 - present

REEC Assistant/Associate Professor Search and Selection Committee, 2007

PMG and Stored Products Group Research Engineer Search and Selection Committee, 2006

CEAT History Advisory Committee, 2008 – 2009

CEAT Material Science Advisory Committee, 2007, present

ASABE student branch advisor, 2009 – 2011, 2013 - 2015.

Student academic advisor, 2010 – present

Chair of search committee for biomechanical engineering faculty position, 2013

Chair of search committee for biomechanical teaching faculty position, 2013



**College**

Student Judicial Committee, 2008 - 2011

Assistant/Associate Professor of Renewable Energy and Power Search Committee, 2008

Assistant/Associate Professor of Stored Product Entomology Search Committee, 2007

College Engineering Architecture and Technology ENGR 3313 Material Science Course Oversight Committee, 2006-2007

College Engineering Architecture and Technology Humanities and Social Sciences Monitoring Course Oversight Committee, 2007 – present

Program Chair for the Stored Product Impact Team, 2007 – present

Environmental Science Graduate Program Committee, 2007 – present

Study Abroad ENGR 4060 committee, 2007 – present

CASNR Student Council Advisor, 2009 – present

International Ag Programs Support Group, 2009 - present

CEAT Dean and Vice President Search Committee, 2011

DASNR Asst. Dean Search Committee, 2011

Academic Integrity Liaison, 2012-13



## University

Faculty Council, 2012-2014: Academic Standards and Campus Facilities and Safety Committees

Student Judicial Affairs Committee, 2009 – 2011

Graduate College Faculty member, 2007 – present

Suicide Prevention task force, 2011 – present

Tuition Reimbursement Committee, 2013

Reinstatement Committee, 2013

## **Projects, presentations and publications**

Delivered over **126 presentations and conducted workshops** about agricultural product storage and quality, grain quality management, and biofeedstock packaging, handling and storage.

**Project advisement:** Ag product storage and quality maintenance (non-publishable projects)

International: China, Brazil, Azerbaijan, Germany, Italy, Portugal, Spain, Canada

United States:

- Canola storage (3 different companies)
- Grain bin integrity
- Grain bin safety
- Testing of grain entrapment rescue equipment (8 different companies)
- Testing of fumigation and non-chemical treatment methods for ag product storage (5 different companies)
- New grain bin standards through ASABE



- Aeration techniques for non-traditional crops (four different companies)

### **Invited Presentations**

1. Grain Quality and Aeration. 2013. Rescue and Safety Training for Sunray Coop, Sunray, TX. March 21-22, 2013.
2. Grain Quality and Safety, 2013. Ontario AgriBusiness Association, February 20, 2013.
3. Grain Quality Management, 2013. GEAPS Leadership Training, London, Ontario, August 21, 2013.
4. Grain Quality and Aeration Management, 2013. Grain Entrapment Prevention Conference, Lincoln, Nebraska, March 11-13, 2013.
5. Aeration Management and Grain Quality, Texas High Plains GEAPS Workshop, Amarillo, TX, January 29-30, 2013.
6. Storing Canola in Warm Climates, 2012. Ag Expo, Oklahoma City, OK. Dec. 5, 2012.
7. Grading Standards. Postharvest Loss Symposium. 2012. Embrapa, Brazil. October 22-24, 2012.
8. “What is Biosystems Engineering?” Centennial Rotary Club. 2012. Stillwater, OK. October 10, 2012.
9. Fumigation Certification Training Workshop. 2012. University of Missouri, January 23-24, 2012. Rolla, Missouri.
10. “Grain Bin and Entrapment Safety”. 2012. Field Services Unit, February 28, 2012. Stillwater, OK
11. “Advanced Aeration Management”, 2012. High Plains GEAPS Workshop, January 25, 2012. Amarillo, TX.
12. “Developing a Safety Culture”, 2012. GEAPS Exchange International Meeting, March 4, 2012. Minneapolis, Minnesota.
13. “Advanced Aeration Management”, 2012. Grain Entrapment Prevention Conference, March 20, 2012. St. Louis, Missouri.
14. Four class lectures for GEAPS/KSU Distance Learning Class on Grain Bin Entrapment, April 19, 2012. Manhattan, KS.
15. “Storing Maize Safely”, 2012. Chapingo University Tour in USA, July 11, 2012. Stillwater, OK.
16. “Fumigation for quality preservation”, 2011. AgExpo, November 2, 2011. Oklahoma City, Oklahoma
17. “Grain Quality and Safety in Storage”, June 23, 2011, SATRA Safety Training, Frankenmuth, MI.



18. Invited speaker for Women in Engineering, March 29, 2011, Stillwater, OK.
19. “Grain Bin Sealing, Sanitation and CLF Techniques”. Oklahoma Fumigation Certification Workshop. March 29, 2011. Stillwater, OK.
20. “Grain Quality Assurance”, Grain Bin Safety and Rescue Symposium, March 22-24, 2011, Assumption, Illinois.
21. “Grain Bin Sealing Procedures and Entrapment Rescue”. Missouri Fumigation Certification Workshops. January 11, 2010. Columbus, MO.
22. “POD: Aspen Lift High Angle Rescue Equipment”, GEAPS Exchange, March 1, 2011. Portland, OR.
23. “Grain Quality Management”, California Grain And Feed Association, January 13, 2011, Webinar.
24. “Aeration Improvement Techniques”. Missouri Fumigation Certification Workshops. January 10, 2010. Columbus, MO.
25. “New Ag Product Storage Techniques: Quality in the Preservation”, 2010. AgExpo, November 4, 2010. Oklahoma City, Oklahoma
26. “Fumigation Importance and Improvement Methods”. 2010. Ag Expo. November 4, 2010. Oklahoma City, Oklahoma.
27. “Bin Sealing and Sanitation Procedures”. 2010. Fumigation Certification Practical Training. September 28, 2010. Stillwater, Oklahoma
28. “Monitoring Equipment: Types, Uses, and Importance. 2010. Fumigation Certification Practical Training. September 28, 2010. Stillwater, Oklahoma..
29. “Extension Service Establishment in Azerbaijan”. 2010. AIM. August 1, 2010. Agjabeddi, Azerbaijan.
30. “Dairy and Poultry Rations and Husbandry for Food Quality”. 2010. AIM. July 30, 2010. Agjabeddi, Azerbaijan.
31. “Improved Insect Management”. 2010 Oklahoma Elevator Workshop. March 23, Enid, OK, March 23, 2010. Weatherford, OK, and April 6, Shawnee, OK.
32. “Aeration, Part I and II”, Mid Kansas Cooperative Association, March 2 and 3, 2010. McPherson, Kansas.
33. “Gas Monitoring”. Triangle Insurance Employee Training. January 24, 2010. Enid, Oklahoma.



34. “Grain Bin Sealing Procedures and Entrapment Rescue”. Missouri Fumigation Certification Workshops. January 12, 2010. Columbus, MO.
35. “Learning for a Lifetime: Oklahoma to Azerbaijan”, Lion’s Club, December 10, 2009.
36. “Biomass: Handling, Storage and Transportation”, Oklahoma Biofuel Feedstock Field Day, October 21, 2009, Chickasha, OK.
37. “Grain Bin Sealing”. Oklahoma Fumigation Certification Workshop. October 20, 2009. Stillwater, OK.
38. “Aeration Basics”. Oklahoma Fumigation Certification Continuing Education Workshop, October 6 - 7, 2009 Stillwater, OK.
39. “Grain Storage Management”. Army National Guard destined for Afghanistan, May, 2009. Stillwater, OK.
40. “S.L.A.M. Grain Quality Management”. Stillwater Milling Employee Development Workshop, April 23, 2009, Stillwater, OK.
41. “Grain Bin Sealing and Safety”. Oklahoma Fumigation Workshop. April 14, 2009. Stillwater, OK.
42. “Ozone Fumigation”. 2009 Oklahoma Elevator Workshop. March 24, Enid, OK, March 25, 2009. Weatherford, OK, and March 31, Shawnee, OK.
43. “When and How Long to Aerate”. 2009 Oklahoma Elevator Workshop. March 24, Enid, OK, March 25, 2009. Weatherford, OK, and March 31, Shawnee, OK.
44. “Sunflower and Oil Seed Storage”. 2009 Oklahoma Elevator Workshop. March 24, Enid, OK, March 25, 2009. Weatherford, OK, and March 31, Shawnee, OK.
45. “Stored Product Engineering: Focused Diversity in a World of Engineering Challenges”. ASABE Oklahoma Section Meeting, February 6, 2009. Stillwater, OK.
46. “Stored Product Engineering: What We Do and What It Means To You”. Loyal Lions Club, February 4, 2009. Loyal, OK.
47. “Fan Controls: When to Aerate Grain and For How Long”. Gulf Coast Grain Handlers Conference, January 22, 2009. El Campo, Texas.
48. “Grain Bin Sealing Procedures”. Missouri Fumigation Certification Workshops. January 13, 2009. Columbus, MO.



49. “Biofuels Basics: Harvesting, Handling and Storage”. Oklahoma Ag-Expo. November 5, 2008, Oklahoma City, OK.
50. “Bale Storage Basics”. Field to Fuel Field Day. October 12, 2008, Chickasha, OK.
51. “Grain Bin Sealing”. Oklahoma Fumigation Certification Workshop. October, 2008. Stillwater, OK.
52. “Closed Loop Fumigation”. Oklahoma Fumigation Certification Workshop. October, 2008. Stillwater, OK.
53. “Grain Bin Entrapment Rescue”. Oklahoma Fumigation Certification Workshop. October, 2008. Stillwater, OK.
54. “Storage of Biofuels By-Products”. Oklahoma Fumigation Certification Workshop. October, 2008. Stillwater, OK.
55. “Storage Methods for Maintaining Quality Seed Characteristics”. Lubbock County Elevator Workshop, April 25, 2008, Lubbock, TX.
56. “Biofuels and Their Effect on Grain Storage”. Elevator Workshops at Shawnee, Catoosa, Weatherford, and Enid, OK. March 31<sup>st</sup>, April 1<sup>st</sup>, April 3<sup>rd</sup>, and April 10<sup>th</sup>, 2008.
57. “Cost of Closed-Loop Fumigation”. Elevator Workshops at Shawnee, Catoosa, Weatherford, and Enid, OK. March 31<sup>st</sup>, April 1<sup>st</sup>, April 3<sup>rd</sup>, and April 10<sup>th</sup>, 2008.
58. “Management of Empty Bins”. Elevator Workshops at Shawnee, Catoosa, Weatherford, and Enid, OK. March 31<sup>st</sup>, April 1<sup>st</sup>, April 3<sup>rd</sup>, and April 10<sup>th</sup>, 2008.
59. “Cellulosic Feedstock to Ethanol: Impact on Custom Harvesting”. US Custom Harvesters Association. February 28 – 29, 2008. Wichita Falls, TX.
60. “Grain Aeration: Just the Basics, Ma’am”. Texas Gulf Coast GEAPS Chapter Workshop. January 24, 2008. Corpus Christi, TX.
61. “Grain Bin Sealing Procedures and Closed Loop Fumigations”. Missouri Fumigation Certification Workshops. January 14 – 15, 2008. Columbus, MO.
62. “Grain Handling Safety for Custom Harvesters”. Custom Harvesters Insurance, April 8, 2008. Enid, OK.
63. “Aeration and Temperature Management”. 7<sup>th</sup> National Stored Product IPM Conference, April 18-20, 2007. Stillwater, OK.



64. “Grain Aeration: Just the Basics, Ma’am”. Great Plains GEAPS Chapter Workshop. May 4, 2007. Lubbock, TX.
65. “Successful Storage of Ag By-Products”. Oklahoma Ag-Expo. November 28, 2007, Oklahoma City, OK.
66. “Aeration: Just Beyond the Basics”. Tri-State GEAPS Chapter Workshop. January 22, 2008. Amarillo, TX.
67. “Grain Bin Sealing”. Oklahoma Fumigation Certification Workshop. September, 2007. Stillwater, OK.
68. “Closed Loop Fumigation”. Oklahoma Fumigation Certification Workshop. September, 2007. Stillwater, OK.

## PROJECTS AND TRAINING

**Nineteen closed loop fumigation systems designed** and in successful operation (50,000 bu up to 4 million bu)

**Three non-traditional crop aeration systems designed** and in successful operation (canola and wildflower/grass seed mixtures)

**Five cereal grain aeration systems designed and in successful operation.**

**One extraction system designed** for grain bin rescue.

**Consulted on the design for 8 cofferdams** for grain bin entrapment rescue.

## PUBLICATIONS

Monograph and Book Chapters – 5

Refereed Publications: 30, 10 first author

Professional Papers – 19, 6 first author

Abstracts and Non-refereed Publications – 1

Extension – 9, 7 first author



### **Books & Monographs**

1. 2006 (revised in 2007, 2008, 2012). "Storage" (Chapter 20). Great Plains Canola Production Handbook, MF-2734, Kansas State University Agricultural Experiment Station and Cooperative Extension Service. Pages 14 - 16.
2. 2009. "Electricity". Agriculture Career Development: Comprehensive Agricultural Mechanics . CIMC, Oklahoma Department of Career and Technology Education
3. 2010. "Final Report to Azerbaijan: Dairy and Poultry Feeding and Husbandry", USAID, Chemonics.
4. 2010. "Agricultural Market Information System for Azerbaijan". USAID. Chemonics and AIM, Azerbaijan.
5. 2012. Jones, Carol, Mark Casada, and Otto Loewer.. "Drying, Handling and Storage of Raw Commodities." Ch. 10 in *Stored Product Protection*, a web publication and print publication in 2012, edited edited by David W. Hagstrum, Thomas W. Phillips and Gerrit Cuperus. Available at <http://www.entomology.ksu.edu/doc4909.ashx>.

### **Peer-Reviewed Publications:**

1. Sharma, B., **C. Jones**, and R. Ingall. 2013. Biomass supply chain design and analysis: basis, overview, modeling, challenges, and future. *Renewable & Sustainable Energy Reviews* 24: 608-627.
2. Hardin, J.A., P.R. Weckler, and C.L. **Jones**. 2013. Microwave backscatter response of pecan tree canopy samples for estimation of pecan yield in situ using terrestrial radar. *Computers and Electronics in Agriculture* 90: 54-62.
3. Pasangulapati, V, A. Kumar, **C. Jones**, and R. Huhnke. 2012. Characterization of switchgrass, cellulose, hemicellulose and lignin for thermochemical conversions. *Journal of Biobased Materials and Bioenergy*.
4. Hardin, J. A., **C. L. Jones**, P. R. Weckler, N. O. Maness, J. W. Dillwith, and R. D. Madden. 2012. Rapid in situ Quantification of Leaf Cuticular Wax Using FTIR-ATR. *Transactions of the ASABE* In review.



5. Hardin, J. A., M. W. Smith, **C. Jones**, P. R. Weckler, and B. S. Cheary. 2012. In situ measurement of pecan leaf nitrogen concentration using a chlorophyll meter and Vis-NIR multispectral camera. *HortScience* 47(7): 955–960.
6. **Jones, C.** and G. Dilawari. 2012. Quality estimation of canola using machine vision and VIS-NIR spectroscopy. *Proc. 9<sup>th</sup> International Conference on Controlled Atmosphere and Fumigation of Stored Products*. Antalya, Turkey, 15 – 19 October, 2012. CAF268.
7. Okiror, G., and **C. Jones**. 2012. Effect of temperature on the dielectric properties of low acyl gellan gel. *Journal of Food Engineering*.
8. Pasangulapati, V., K. D. Ramachandriya, A. Kumar, M. R. Wilkins, **C. L. Jones**, and R. L. Huhnke. 2012. Effects of cellulose, hemicellulose and lignin on thermochemical conversion characteristics of the selected biomass. *Bioresource Technology*. (Accepted, Mar 9, 2012).
9. Lawrence, J., D. Maier, J. Hardin, and **C. Jones**. 2012. Development and validation of a headspace model for a stored grain silo filled to its eave. *Journal of Stored Product Research* 49: 176-183.
10. **Jones, C.** and G. Okiror. 2011. Improved models for predicting moisture content in dried pineapples using dielectric properties. *Proc. 9<sup>th</sup> International Conference on Electromagnetic Wave Interaction with Water and Moist Substances, ISEMA, Kansas City, MO, USA. 31May – 3June.*: 272-278.
11. Okiror, G. and **C. Jones**. 2011. Effect of temperature on the dielectric properties of low acyl gellan gel. *Proc. 9<sup>th</sup> International Conference on Electromagnetic Wave Interaction with Water and Moist Substances, ISEMA, Kansas City, MO, USA. 31May – 3June.*: 92-99.
12. Opit, G., **C. Jones**, F. Arthur, T. Phillips, E. Bonjour, and R. Beeby. 2011. Efficacy of Heat Treatment for Disinfestation of Concrete Grain Silos. *Journal of Economic Entomology* 104(4): 1415-1422.
13. Bonjour, E. G. Opit, J. Hardin, **C. Jones**, M. Payton, and R. Beeby. 2011. Efficacy of ozone fumigation against the major grain pests in stored wheat. *Journal of Economic Entomology* 104(10): 308-316
14. Sharma, B., **C. Jones**, and A. Khanchi. 2011. Physical properties of switchgrass (variety: Kanlow) as related to before and after frost harvesting. *Biological Engineering Transactions* 4(1): 43-54.



15. Aminatou, B., S. Gautam, G. Opit, J. Talley, and **C. Jones**. 2010. Population growth and development of the Psocid *Liposcelis pearmani* Lienhard (Psocoptera: Liposcelididae) at constant temperatures and relative humidity. *Proc. 58<sup>th</sup> ESA, San Diego, CA. 12Dec – 16Dec*.
16. Hardin, J., **C. Jones**, E. Bonjour, R. Noyes, R. Beeby, D. Eltiste, and S. Decker. 2010. Ozone fumigation of stored grain; closed-loop recirculation and rate of ozone consumption. *Journal of Stored Products Research* 46(2010) 149-154.
17. Bonjour, E., G. Opit, **C. Jones**, J. Hardin, and R. Beeby. 2010. Efficacy of ozone fumigation against the major grain pests in stored wheat. *Journal of Economic Entomology*, accepted for publication.
18. **Jones, C.**, and F. Ding. 2010. Identification of Stored-grain Insects using Microwave/RF Electric Fields. *Proc. 10th IWCSPP, Lisbon, Portugal, 27Jun-2Jul*.
19. Hardin, J., G. Opit, E. Bonjour, and **C. Jones**. 2009. Efficacy of ozone against the psocids *Liposcelis entomophila*, *L. bostrychophila*, and *L. decolor* (Psocoptera: Liposcelididae). *Proc. ESA Intl. Conf., Indianapolis, IN. 13Dec – 16Dec*.
20. **Jones, C.**, F. Ding and P. Weckler. 2009. RF/Microwave technology application for identification of stored product insects. *Sensing and Instrumentation for Food Quality and Safety*, DOI 10 1007/s11694-009-9089-x.
21. Ding, F., **C. Jones**, and P. Weckler. 2009. Identification and detection of stored grain insects with RF and microwave technology. *Transactions of the ASABE*. 52(6): 1-10.A
22. **Jones, C.** and F. Ding. 2008. Identification and detection of stored grain insects with RF and microwave technology. *Proc. CIGR Intl. Conf. Agricultural Engineering, Iguassu Falls City, Brazil. 31 Aug – 4 Sept*.
23. **Jones, C.** and G. Dilawari. 2008. Estimating quality of canola seed using a flatbed scanner. *Proc. CIGR Intl. Conf. Agricultural Engineering, Iguassu Falls City, Brazil. 31 Aug – 4 Sept*
24. **Jones, C.**, E. Bonjour, R. Beeby, R. Noyes, and T. Phillips, 2008. Closed loop fumigation of a small rural concrete elevator in a growing urban setting. *Proc. Int. Conf. Controlled Atmosphere and Fumigation in Stored Products*, Chengdu, China. 21 Sept. – 26 Sept. Executive Printing Services, Clovis, CA, U.S.A.



25. Bonjour, E., **C. Jones**, R. Noyes, J. Hardin, R. Beeby, D. Eltiste, and S. Decker, 2008. Efficacy of ozone against insect pests in wheat stored in steel grain bins. *Proc. Int. Conf. Controlled Atmosphere and Fumigation in Stored Products*, Chengdu, China. 21 Sept. – 26 Sept. Executive Printing Services, Clovis, CA, U.S.A
26. Lu, Y., S. Li, J. Bai, and **C. Jones**. 2008. Canopy spatial distribution and identification using hyperspectral data in winter wheat. *Communication of Soil Science and Plant Analysis* [http://www.informaworld.com/smpp/title~db=all~content=t713597241~tab=issueslist~branches=40 - v4040\(7&8\) 1240 – 1253](http://www.informaworld.com/smpp/title~db=all~content=t713597241~tab=issueslist~branches=40-v4040(7&8)1240-1253).
27. **Jones, C**, N. Maness, M. Stone, and R. Jayasekara. 2007. Chlorophyll Estimation Using Multi-spectral Reflectance and Height Sensing. *Transactions of the ASABE* 50(5): 1867 - 1872.
28. **Jones, C.L.**, P.R. Weckler, N.O. Maness, R. Jayasekara, M.L. Stone, and D. Chrz. 2007. Remote sensing to estimate chlorophyll concentration in spinach using multi-spectral plant reflectance. *Transactions of the ASABE* 50(6): 2267 – 2273.
29. Lu, Y., S. Li, J. Wang, **C. Jones**, R. Xie, W. Huang, S. Gao, and Z. Wang. 2007. Identification of wheat plant-type using NDVI and COV. *New Zealand Journal of Agricultural Science* 50: 1149-1157.
30. **Jones, C.**, 2006. Plant characteristic estimation using sonar, multispectral reflectance, and electromagnetic response. Doctoral Dissertation, Oklahoma State University, Stillwater, OK.
31. Brusewitz, G. H., and **C. Stephens (Jones)**. 1979. Wheat protein variation between loads. *Transactions of the ASAE* 22(6): 1431 – 1438.

#### Refereed Publications in preparation:

1. Sharma, B., **C. Jones**, N. Maness and A. Khanchi. 2013. Estimation of water stress using hyperspectral sensing and partial least square regression. *Computers and Electronics in Agriculture*. Status: Accepted for publication pending revisions.
2. Sekhon, J. K., N. O. Maness, **C. L. Jones**. 2013. Solvent extraction with liquid propane: a value added processing technique for cilantro (Target Journal J Agric. Food Chem) Status: Internal review
3. Sekhon, J. K., N. O. Maness, **C. L. Jones**. 2013. Effect of storage temperature on the stability of volatile composition of dehydrated and propane extracted cilantro (*Coriandrum sativum*) (Target



Journal J Agric. Food Chem) Status: Internal review

4. Sekhon, J. K., N. O. Maness, **C. L. Jones**. 2013. Effect of storage temperature on the stability of color and fatty acid composition of dehydrated and propane extracted cilantro (*Coriandrum sativum*). (Target Journal J Agric. Food Chem) Status: Internal review
5. Sekhon, J. K., N. O. Maness, **C. L. Jones**. 2013. Effect of dehydration on the rate of moisture and volatile loss in cilantro (*Coriandrum sativum*) (Target Journal J Agric. Food Chem) Status: Internal review
6. Okiror, G. and **C. L. Jones**. 2013. Relationship between dielectric properties and soluble solids content of whole apples during ripening. (Target Journal Journal of Food Engineering) Status: Internal Review
7. Okiror, G. and **C. L. Jones**. 2013. Predicting the soluble solids contents of whole apples using dielectric spectroscopy. (Target Journal Transactions of ASABE) Status: Internal Review
8. **Jones, C.** and G. Dilawari. 2013. Non-destructive estimation of free fatty acid content and peroxide value using NIR spectroscopy in canola seed. (Target Journal *Journal of Infrared Spectroscopy*) Status: Accepted for publication pending revisions.
9. **Jones, C.** and G. Dilawari. 2013. Estimating quality of canola seed using a flatbed scanner. (Target Journal *Applied Engineering*) Status: Accepted for publication pending revisions.
10. Sharma, B. and **C. Jones**. 2012. Calculating dew duration. (Target Journal *Transactions of ASABE*). Status: Formatting for submittal
11. Sharma, B., R. Ingalls and **C. Jones**. 2012. Scenario optimization approach for designing supply chain and logistics model for lignocellulosic biomass. (Target Journal *Transactions of ASABE*). Status: Under internal review.
12. Sharma, B., R. Ingalls and **C. Jones**. 2012. Review: supply chain and logistics models for lignocellulosic biomass crops. (Target Journal *Transactions of ASABE*). Status: Under internal review.
13. Khanchi, A., **C. Jones** and B. Sharma. 2012. Characteristics and compositional variation in round and square switchgrass bales under different storage conditions. (Target Journal *Transactions of ASABE*). Status: Under internal review.



### Professional Papers

1. **Jones, C.**, P. Weckler, and T. Bowser. 2003. Feasibility of Steam Generation from Gasified Pork-processing Byproducts. ASAE Paper No. 036176. ASAE, St. Joseph, MI 49085-9659.
2. **Jones, C.**, N. Maness, M. Stone, and R. Jayasekara. 2004. Chlorophyll Estimation Using Multi-Spectral Reflectance and Height Sensing. ASAE Paper No. 043081. ASAE, St. Joseph, MI 49085-9659.
3. **Jones, C.**, N. Maness, M. Stone, and R. Jayasekara. 2004. Sonar and Digital Imagery for Estimating Crop Biomass. ASAE Paper No. 043061. ASAE, St. Joseph, MI 49085-9659.
4. **Jones, C.**, P. Weckler, N. Maness, M. Stone, and R. Jayasekara. 2004. Estimating Water Stress in Plants Using Hyperspectral Sensing. ASAE Paper No. 043086. ASAE, St. Joseph, MI 49085-9659.
5. **Jones, C.**, N. Maness, M. Stone, J. Solie and D. Zavodny. 2005. Variable Rate Nitrogen Application on Row Crop Spinach. ASABE Paper No. 051119. ASABE, St. Joseph, MI 49085-9659.
6. **Jones, C.**, N. Maness, M. Stone, J. Solie, and G. Brusewitz. 2006. Plant Biomass Estimation Using Dielectric Properties. ASABE Paper No. 063092. ASABE, St. Joseph, MI 49085-9659.
7. Dilawari, G. and **C. Jones**. 2007. Estimating Quality of Canola Seed Using a Flatbed Scanner. ASABE Paper No. 073030. ASABE, St. Joseph, MI 49085-9659.
8. Ding, F. and **C. Jones**. 2008. Identification and detection of stored grain insects with RF and microwave technology. Paper No. 084076. ASABE, St. Joseph, MI 49085-9659.
9. Dilawari, G. and **C. Jones**. 2008. Estimating Quality of Canola Seed Using a Flatbed Scanner. ASABE Paper No. 084065. ASABE, St. Joseph, MI 49085-9659.
10. Dilawari, G. and C. Jones. 2008. Estimating Quality of Canola Seed Using a Flatbed Scanner. International Conference on Grain Quality. Chicago, IL.
11. Sharma, B. and **C. Jones**. 2009. The effect of moisture and stage of maturity on physical properties of switchgrass(variety: Kanlow). ASABE Paper No. 096641, ASABE, St. Joseph, MI 49085-9659.
12. Khanchi, A. and **C. Jones**. 2009. Characteristics and compositional variation in round and square sorghum bales under different storage conditions. ASABE Paper No. 096672, ASABE, St. Joseph, MI 49085-9659.



13. Sekhon, J. and C. **Jones**. 2009. Effect of propane extraction on the quality of dried cilantro (*Coriandrum sativum* L.). ASABE Paper No. 097053. ASABE, St. Joseph, MI 49085-9659.
14. Grundmann, J. and C. **Jones**. 2009. Non-destructive quality assessment of pecans using microwave dielectric spectroscopy. ASABE Paper No. 096002, ASABE, St. Joseph, MI 49085-9659.
15. Dilawari, G. and C. **Jones**. 2009. Estimating Quality of Canola Seed Using VIS/NIR Spectroscopy. ASABE Paper No. 096311. ASABE, St. Joseph, MI 49085-9659.
16. Hardin, J. and C. **Jones**. 2009 Ozone fumigation of stored grain; closed loop recirculation and rate of ozone consumption. ASABE Paper No. 096340. ASABE, St. Joseph, MI 49085-9659.
17. Okiror, G. and C. **Jones**. 2010. Modeling the dielectric properties of pineapple during drying. ASABE Paper No. 1008552. ASABE, St. Joseph, MI 49085-9659.
18. Okiror, G. and C. **Jones**. 2010. Predicting the soluble solids content of whole apples using dielectric spectroscopy. ASABE Paper No. 1009061. ASABE, St. Joseph, MI 49085-9659.
19. Sharma, B., C. **Jones**, and A. Khanchi. 2010. Effect of moisture control and maturity stage on physical properties of switchgrass (variety: *Kanlow*). ASABE Paper No. 10xxxx. ASABE, St. Joseph, MI 49085-9659.
20. Megel, A., C. **Jones**, E. Bonjour, and J. Kinder. 2010. Investigation of ethylene gas as a treatment for stored-product insects. ASABE Paper No. 1009576. ASABE, St. Joseph, MI 49085-9659.
21. Kamath, M., R. Ingalls, C. **Jones**, G. Shen, and S. Pulat. 2010. TISCSOFT: A Decision Support System for Transportation Infrastructure and Supply Chain System Planning. Project Number OTCREOS7.1-25. OCOT-OTC Transportation Research.
22. Hardin, J. A., C. L. **Jones**, N. O. Maness, P. R. Weckler, and J. W. Dillwith. 2011. Rapid in situ Quantification of Leaf Cuticular Wax Using FTIR-ATR and DSC. In *2011 ASABE Annual International Meeting*. Louisville, Ky: ASABE.
23. Okiror, G. and C. **Jones**. 2011. "Relationship Between Dielectric Properties and Soluble Solids Content of Whole Apples During Ripening", Session 309 Paper # 1110680 *ASABE Annual International Meeting*. Louisville, Ky: ASABE.



24. Buser, M., A. Megel, E. Miller, **C.L. Jones** and R.L. Huhnke. 2011. Preliminary evaluation of cellulosic biomass storage practices. ASABE 1111770. Presented at the American Society of Agricultural and Biological Engineers, St. Joseph, MI.
25. Miller, E., A. Megel, M. Buser, **C.L. Jones** and R.L. Huhnke. 2011. Preliminary evaluation of storing high moisture energy sorghum bales. ASABE 1111780. Presented at the American Society of Agricultural and Biological Engineers, St. Joseph, MI.
26. Kumar, A., **C.L. Jones** and R.L. Huhnke. 2011. Effect of biomass composition on products during thermochemical conversion as characterized by TG-GC-MS and TG-FTIR. ASABE 1110691. Presented at the American Society of Agricultural and Biological Engineers, St. Joseph, MI.
27. **Jones, C.** and J. Sekhon. 2011. Effect of drying temperature, partial lipid extraction, and storage on the shelf of dehydrated cilantro (*Coriandrum Sativum L.*). ASABE 1111664. Presented at the American Society of Agricultural and Biological Engineers, St. Joseph, MI.
28. Sharma, B., M. Kamath, R. Ingalls, and **C. Jones**. 2011. Scenario optimization approach for supply chain and logistics model of biomass. Center for Excellence in Logistics and Distribution (CELDi), Denver, Colorado, 2011
29. Pasangulapati, V., A. Kumar, **C. L. Jones**, and R. L. Huhnke. Effect of biomass composition on products in thermochemical conversion. Annual International Meeting of American Society of Agricultural and Biological Engineers (ASABE), Louisville, KY, August 7-10, 2011. Oral Presentation.
30. Pasangulapati, V., A. Kumar, **C. L. Jones**, and R. L. Huhnke. Effect of biomass composition on products in
31. Thermochemical conversion. S-1041: Where there's smoke, there's fuel: A symposium on the Thermochemical Conversion of Biomass to Fuels, Stillwater, OK, August 2, 2011. Poster Presentation.
32. Pasangulapati, V., A. Kumar, **C. L. Jones**, and R. L. Huhnke. Characterization of switchgrass using TGA-FTIR for thermochemical conversion. Annual State Conference of Oklahoma EPSCoR, Norman, OK, April 21, 2011. Oral and Poster Presentation.
33. Pasangulapati, V., A. Kumar, **C. L. Jones**, and R. L. Huhnke. Characterization of switchgrass using



TGA-FTIR for thermochemical conversion. 22nd Annual OSU Research Symposium and Research Scholar conference, Stillwater, OK, Feb 23, 2011. Oral Presentation.

34. **Jones, C. L.** and G. Okiror. 2012. Estimation of Corn Stalk Diameters Using Microwave Scattering Parameters. ASABE 12-1337283. Presented at the American Society of Agricultural and Biological Engineers, St. Joseph, MI.
35. Hardin, J., P. Weckler and **C. Jones**. 2012. Estimation of pecan yield using backscattered terrestrial microwave sensing. ASABE 12-1337363. Presented at the American Society of Agricultural and Biological Engineers, St. Joseph, MI.
36. **Jones, C. L.** and Brian Adam. 2012. Traceability: Anderson Project Update. NC213 Annual Meeting, March 5, 2012. Minneapolis, Minnesota.
37. Bajracharya, N., G Opit, J Talley and **C Jones**. 2013. Comparing effectiveness of three traps used to monitor *Tribolium Castaneum* (Coleoptara: Tenebrionidae). Entomological Society of America Conference. Poster #76179. November 10 – 12. Austin, TX
38. Bajracharya, N., G Opit, J Talley and **C Jones**. 2013. Comparing effectiveness of three traps used to monitor *Tribolium Castaneum* (Coleoptara: Tenebrionidae). Entomological Society of America Conference. Poster #76179. November 10 – 12. Austin, TX
39. Bajracharya, N., G Opit, J Talley and **C Jones**. 2013. Fitness cost of phosphine resistance determined by measurement of developmental rates of phosphine-resistant and –susceptible populations of *Rhyzopertha dominica* and *Tribolium castaneum*. Entomological Society of America Conference. Paper #76181. November 10 – 12. Austin, TX

#### **Abstracts and Non-Refereed Proceedings**

1. Maness, N., D. Chrz, E. Kalkan, **C. Jones**, L. Brandenberger, and R. Havener. 2007. Chemical profiling of herbs as alternative or rotation crops with vegetables. *2006 Vegetable Trial Report*. (MP-164); 11 – 15.



### Extension Publications

1. **Jones, C. L.**, E. Bonjour, R. Beeby, M. Walton, D. Woods, and J. Ayers. 2012. Grain Bin Safety, *DVD video production VT1138*. Oklahoma Cooperative Extension Service, Stillwater, Oklahoma.
2. **Jones, C. L.**, 4 class lectures for GEAPS Distance Learning Group. Grain bin rescue and safety, Kansas State University, Manhattan, KS.
3. **Jones, C. L.**, Closed Loop Fumigation Design, Farmers Grain, Pond Creek, OK.
4. **Jones, C.L.** 2011. Grain Bin Safety. BAE Engineering Success 1(4).
5. **Jones, C.L.**, J. Hardin, and E. Bonjour 2011. Design of closed-loop fumigation systems for grain storage structures. *Fact Sheet BAE1111*. Oklahoma Cooperative Extension Service, Stillwater, Oklahoma.
6. **Jones, C. L.**, E. Bonjour, R. Beeby, M. Walton, D. Woods, and J. Ayers. 2011. Grain Bin Safety, *DVD video production VT1138*. Oklahoma Cooperative Extension Service, Stillwater, Oklahoma.
7. **Jones, C.L.** 2010. Keeping Grain in Good Condition. BAE Engineering Success 1(3).
8. **Jones, C.L.** 2010. Grain Bin Entrapment Prevention. BAE Engineering Success 1(1).
9. **Jones, C.L.** 2010. Design of Closed Loop Fumigation Systems for Stored Grain Structures. *Fact Sheet*. Oklahoma Cooperative Extension Service, Stillwater, Oklahoma.
10. **Jones, C.L.** and J. Hardin. 2010. Aeration and cooling of stored grain. *Fact Sheet BAE-1101*. Oklahoma Cooperative Extension Service, Stillwater, Oklahoma.
11. Taylor, R., M. Buser, and **C. Jones**. 2010. Harvesting High Quality Wheat. *Fact Sheet L-341*. Oklahoma Cooperative Extension Service, Stillwater, Oklahoma
12. **Jones, C.L.**, E. Bonjour, and C. Ferris. 2010. Grain Bin Entrapment Rescue. Oklahoma Cooperative Extension Service, Stillwater, Oklahoma. Training manual and DVD in progress
13. **Jones, C.L.** and G. Dilawari. 2008. Aeration systems for flat-bottom round bins. *Fact Sheet BAE-1102*. Oklahoma Cooperative Extension Service, Stillwater, Oklahoma.
14. **Jones, C.L.** and G. Dilawari. 2008. Aeration system design for cone-bottom round bins. *Fact Sheet BAE-1103*. Oklahoma Cooperative Extension Service, Stillwater, Oklahoma
15. **Jones, C.L.** and J.B. Solie. 2007. Storing Oklahoma winter canola. *Fact Sheet BAE-1110*. Oklahoma Cooperative Extension Service, Stillwater, Oklahoma.



16. **Jones, C.L.**, E. Bonjour, T. Royer, D. Lalman, and J. Edwards. 2007. Storage and use of low test weight and sprouted wheat. *Current Report CR-1109*. Oklahoma Cooperative Extensions Service, Stillwater, Oklahoma.
17. Bowser, T., P. Weckler, K. Patil, **C. Jones**, and C. DeWitt. 2004. Biofuel from Hog Slaughter Byproducts. FRIP Report, Spring 2004, pp. 3 – 7, Oklahoma Food and Agricultural Products Research and Technology Center, Stillwater, Oklahoma.

## INTERVIEWS AND PRESS

1. Grain Bin Safety, Local Amarillo news station. January 30, 2013.
2. Grain Journal, Aspen Lift and confined spaces rescue. March 30, 2011. Kansas City, MO.
3. KWTv 9 News: In the Field with Ron Hayes, September 20, 2008, Biofeedstock Research at South Central Research Station, Chickasha, OK.
4. KWTv 9 News: In the Field with Ron Hayes, October 13, 2008, LCB Storage and Handling, Chickasha, OK.
5. 25 Fox News with Nick Winkler, October 13, 2008, LCB Storage and Handling, Chickasha, OK.
6. Sun Up, October 13, 2008, LCB Storage and Handling, Chickasha, OK.
7. South West Farm Press, October 13, 2008, LCB Storage and Handling, Chickasha, OK.
8. Impact Magazine, November 2, 2008, Engineering Study Abroad Classes, Stillwater, OK.
9. Stillwater NewsPress, September 4, 2010, O-State helping ag in Azerbaijan, Stillwater, OK
10. Aeration: importance to grain bin safety, Amarillo 5 PM News. January, 2012.
11. Grain Bin Safety, St Louis television stations, March 12, 2012.
12. Soybean Commodity Grading System, Sinope, Mato Grosso, Brazil, September, 2012.
13. Three quotations in articles in the *Grain Journal* about grain bin safety, 2012

## TECHNICAL PAPER EXTERNAL REVIEWER 2003-Present



|                             |   |
|-----------------------------|---|
| Biological Engineering      | 2 |
| Applied Engineering         | 1 |
| Stored Product Journal      | 6 |
| Journal of Food Engineering | 2 |

### **GRADUATE STUDENTS ADVISED**

|   |                 |
|---|-----------------|
| Geetika Dilawari, Doctoral Student (Research Engineer),                       | Completion 2011 |
| Anthony Megel, Masters Student (Research Engineer),                           | Completion 2011 |
| Jim Hardin, Doctoral Student (Gra - Processing),                              | Completion 2012 |
| Bhavna Sharma, Doctoral Student (Gra - Biofuels),                             | Completion 2012 |
| Amit Khanchi, Doctoral Student (Gra - Biofuels),                              | Completion 2012 |
| Jasreen Sekhon, Doctoral Student (Gra - Processing)                           | Completion 2013 |
| Grace Okiror, Doctoral Student (Fulbright Scholar),                           | Completion 2012 |
| Vamsee Pasangulapati, Masters Student (Gra – Biofuels)                        | Completion 2012 |
| Josh Grundmann, masters student (GRA - processing),                           | Completion 2009 |
| Kevin Moore, doctoral student (Research Engineer) anticipated completion 2017 |                 |

### **GRADUATE COMMITTEES SERVED**

|  |                 |
|--|-----------------|
| Joe Dvorak, MS, BAE                                      | Completed 2006  |
| Wade Svetgoff, MS, Ag. Economics                         | Completed 2009  |
| Boubakary Aminatou, MS, Entomology                       | (Deceased)      |
| Shane Hutto, MS, Horticulture And Landscape Architecture | Completion 2011 |



|   |                             |
|---|-----------------------------|
| Luis Serranto, MS, BAE                                | Completed 2011              |
| Nisha Shakya, MS, Entomology                          | Anticipated Completion 2013 |
| Annie Nsofoah, MS, Ag Economics                       | Completed 2012              |
| Vince Schielack, Doctoral Student (Research Engineer) | Anticipated Completion 2014 |
| Brak Seyoum, MS, Ag Economics                         | completed 2013              |

## RESEARCH GRANTS AND CONTRACTS AND IN KIND CONTRIBUTIONS

**Total Grants \$11,391,713 Funded; pending \$12,460,531**

1. Co-Principal Investigator, “Harvesting, Handling and Quality Preservation for Horticultural and Alternate Commodities”, with N.O. Maness and P. Weckler. USDA-CSREES, **\$185,197**, 2005-2007. **Funded.**
2. Co-Principal Investigator, “Harvesting, Handling and Quality Preservation for Horticultural and Alternate Commodities”, with N.O. Maness and P. Weckler. USDA-CSREES, **\$231,055**, 2006-2008. **Funded**
3. **Principal Investigator**, “Sitlington Enriched Graduate Scholarships,” Sitlington Endowment, **\$15,000**. 2007-2009. **Funded**
4. **Principal Investigator**, “Postharvest Storage, Handling and Protection of Canola in Oklahoma”, Oklahoma Agricultural Experiment Station and the Oklahoma Cooperative Extension Service, Team Initiative Program, **\$30,000**, 2006-2008, assigned by Tom Phillips to Carol Jones. **Funded**
5. Co-Principal Investigator, “Pest Management Strategies for Stored Products: Raw Grain and Value-Added Foods,” with Criswell, Phillips (KSU), Arthur (KSU), Campbell (KSU), Towes (KSU) and Casada (KSU), USDA CSREES Pest Management Alternatives Program, **\$196,205**, 2005-2007. **Funded**



6. Co-Principal Investigator, “Harvesting, Handling and Quality Preservation for Horticultural and Alternate Commodities”, with N.O. Maness and P. Weckler. HATCH, **\$231,055**, 2007-2008. **Funded**
7. **Principal Investigator**, “Grain Storage Methods to Protect Product Quality and Security”, with Criswell and Adams, OCES, **\$10,000**. 2007-2009. **Funded**
8. **Principal Investigator**, “Closed Loop Ozone Fumigation”, contract research with AO3, Inc, Olathe, KS, **\$12,240**. 2008. **Funded**
9. **Principal Investigator**, “Demonstration Bin with Video Capabilities”, OCES Capital Improvement Program, 2008. **\$13,000**. **Funded**
10. **Principal Investigator**, Oklahoma Bioenergy Center for “Harvesting and Handling Equipment to Meet the Demands of Oklahoma Lignocellulosic Biomass under Indigenous Growing Conditions”, 2008 - 2009, **\$160,000**, co-PIs Weckler, Huhnke, Wu. **Funded**
11. **Principal Investigator**, Oklahoma Bioenergy Center for “From the Field to the Refinery – A Systems Approach to Modeling the Logistics Value Chain for Switchgrass”, 2008 - 2009, **\$160,000**, co-PIs Collins, Epplin, Huhnke, Ingalls. **Funded**
12. Co-Investigator, Oklahoma Bioenergy Center for “Demonstration of switchgrass development and production”, 2008 – 2009, **\$50,000**, co-PIs Wu, Zhang, Caddel. **Funded**
13. Co-Principal Investigator, “Harvesting, Handling and Quality Preservation for Horticultural and Alternate Commodities”, with N.O. Maness and P. Weckler. USDA-CSREES, **\$172,234**, 2008-2010. **Funded**
14. **Principal Investigator**, “Sitlington Enriched Graduate Scholarships,” Sitlington Endowment, **\$15,000**. 2008-2010. **Funded**



15. Co-Investigator, OTC-REOS for “A Decision Support System for Transportation Infrastructure and Supply Chain System Planning, 2008 – 2010, **\$450,000**, PI M. Kamath, co-PIs R. Ingalls and C Jones. **Funded**
16. Co-Principal Investigator, “Renovation of Infrastructure in the Stored Product Research and Education Center Research Laboratory”, with G. Opit and E. Bonjour. OSU Critical Research Facilities Program, **\$141,700**, 2008-2009. **Funded**
17. Co-Principal Investigator, “Harvesting, Handling and Quality Preservation for Horticultural and Alternate Commodities”, with N.O. Maness and P. Weckler. USDA-CSREES, **\$174,000**, 2009-2011. **Funded**
18. **Principal Investigator** for “Field to Fuel... the Sorghum Connection. Large-scale Research for the Development of the Oklahoma Sorghum-as-Fuel Industry”, 2009 – 2012, \$374,270 total, co-PIs C. Godsey, G. Kakani, D. Bellmer and J. Mosali. Oklahoma Bioenergy Center. Total Project **\$250,000** **Funded**
19. Co-Principal Investigator, “Dielectric Properties of Frozen Foods”. Contract to University of Nebraska for work under USDA-CSREES grant. 2009 – 2010, with P. Weckler, **\$25,000**, **Funded**
20. **Principal Investigator** for “E-IPM Grant for Stored Grain”, 2009-2010. **\$7,204**, co-PIs T. Royer. **Funded**
21. Co-Principal Investigator for “Sustainable Feedstock Production Supply Systems to Support Cellulosic Biorefinery Industries”, 2009 – 2013, **\$4,212,845**, co-PIs from OSU, Idaho National Lab, Noble Foundation, AGCO Industries, Stinger Inc., USDA-CSREES. **Funded**



22. Co-Principal Investigator for “Implementing and Evaluating Traceability Technology in Wheat Storage and Handling”, 2010-2012, **\$50,000**, co-PIs Adams and Biros, Anderson Research Grant Program.  
**Funded**

23. Co-Principal Investigator , Hay Preference and Performance of Beef Cattle”, 2009 – 2010. **\$83,998**.  
With R. Huhnke, Chris Richards, and D. Lalman. **Funded**

24. Co-Principal Investigator, “Integration of Advanced Logistical Systems and Focused Bioenergy Harvesting Technologies to Supply Crop Residues and Energy Crops in Densified Large Square Bale Format”, DOE, 2009-2012, **\$85,000** (part of AGCO proposal totaling approximately \$4.8 million).  
**Funded**

25. **Principal Investigator**, “Sitlington Enriched Graduate Scholarships,” Sitlington Endowment, **\$15,000**.  
2010-2012. **Funded**.

26. Co-Investigator, ” Torrefaction and densification of switchgrass to improve syngas quality and transportation logistics”, Kumar, Patil, Jones, Bellmer, and Tumuluru, (SunGrant), \$160,000 **Funded**

27. Co-Investigator, “Energy Auditing and Energy Management for Feedmills ”, Texas Cattle Feeder Association, with S. Frazier, M. Buser, **\$5,000** Co-Investigator , **Funded**.

28. Co-Investigator ,“REU Site: Interdisciplinary Approach to Sustainable Biobased Products and Energy Developmnet”, NSF, 2013-2016, \$303,301 pending funding

29. **Principal Investigator**, “Teaching Equipment Requests”, CEAT Teaching Funds, 2012-2013. \$80,535.  
With P. Weckler and A. Kumar. **Funded**

30. **Primary Investigator**. “Canola Storage in Warm Climates”, NorthStar and Partners Industry Funding, 2013-2015, anticipated **\$85,000** with P. Kenkel. Pending funding.

31. Co-Principal Investigator. “Developing a Community of Practice of Secondary Educators and Higher



Education Faculty to Improve STEM Literacy in Sustainable Energy for Secondary Students”, USDA SPECA grant, 2013-2015. **\$50,000**, with Atiyeh, Baker, Dunford, Frazier, Kakani and Kumar. Pending funding.

32. Co-Principal Investigator. “Center of Excellence for Alternative Jet Fuels and Environment” FAA-COE-AJFE, with Karagozian, A. et al., 10/1/2013-9/30/2023, \$11,987,230. Pending funding
33. **Principal Investigator**. “Canola Storage in Southern Climates”. Northstar Oilseed Co. 10/1/2013 – 9/29/2014. **\$35,000**. Pending funding.



**Documents considered for this report:**

Depositions:

Curtis Williams  
Earvin Wade  
Howard Ferguson  
Braxton Rascoe  
Wilbur Parker  
Scott Chantt  
RP Watson (3)  
Dennis Ryman  
Brian Lilley  
Randall Turner  
Daniel Ponton  
Brad Henry  
Patrick Rowe

Exhibits:

40 (Watson), 47, 49, 69, 70, 97—119  
Turner 1 – 30

Reports:

Lester Rich  
Schumacher  
Steve Brown  
Mueller

Plaintiff's responses to defendant's first interrogatory  
Severn, Meherrin 1<sup>st</sup> Amended Answers to defendant's 1<sup>st</sup> interrogatory

Pictures from initial mailing from S. Epstein

Sketches of dome and weather (temperature) data received 5/15/13



**Testimony :**

I have not testified in any legal proceedings in the last four years.

**Compensation for this case :**

My charges for this case are \$300 per hour for consulting, research, deposition and testimony time. The client will also pay any expenses (hotel, car, and airfare) for my travel while providing depositions, testimony or research.

*Carol A. Jones*